

WHAT IS CLAIMED IS:

1. A heat treatment apparatus comprising:

a reaction tube;

a gas supply means for supplying gas into the reaction tube and heating or cooling the gas;

a light source for heating a substrate disposed in the reaction tube; and

means for switching on/off the light source in a pulse form,

2. An apparatus according to claim 1, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

3. An apparatus according to claim 1, wherein the gas is at least one selected from the group consisting of nitrogen, helium, argon, krypton, and xenon.

4. A heat treatment apparatus comprising:

a reaction tube;

a gas supply means for supplying gas into the reaction tube and heating or cooling the gas;

a light source for heating a substrate disposed in the reaction tube; and

means for switching on/off the light source in a pulse form,

wherein the light source is provided outside of the reaction tube, and

wherein while gas heated by the gas supply means is supplied, the light source is switched on/off in a pulse form to heat the substrate.

a reaction tube;

a gas supply means for supplying gas into the reaction tube and heating or cooling the gas;

a light source for heating a substrate disposed in the reaction tube;

a first means for heating the substrate by switching on/off the light source in a pulse form with a cycle of one second or shorter; and

a second means for heating the substrate by switching on/off the light source in a pulse form with a cycle of one second or longer.

11. An apparatus according to claim 10, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

12. An apparatus according to claim 10, wherein the gas is at least one selected from the group consisting of nitrogen, helium, argon, krypton, and xenon.

13. A heat treatment apparatus comprising:

a reaction tube;

an exhaust means for reducing a pressure in the reaction tube;

a gas supply means for supplying gas into the reaction tube and heating or cooling the gas;

a light source for heating a substrate disposed in the reaction tube; and

means for switching on/off the light source in a pulse form.

14. An apparatus according to claim 13, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

15. An apparatus according to claim 13, wherein the gas is at least one selected from the group consisting of nitrogen, helium, argon, krypton, and xenon.

16. A heat treatment apparatus comprising:

a reaction tube;

an exhaust means for reducing a pressure in the reaction tube;

a gas supply means for supplying gas into the reaction tube and heating or cooling the gas;

a light source for heating a substrate disposed in the reaction tube; and

means for switching on/off the light source in a pulse form,

wherein the light source is provided outside of the reaction tube, and

wherein while gas heated by the gas supply means is supplied under a condition that the reaction tube is kept in a reduced pressure, the light source is switched on/off in a pulse form to heat the substrate.

17. An apparatus according to claim 16, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

18. An apparatus according to claim 16, wherein the gas is at least one selected from the

group consisting of nitrogen, helium, argon, krypton, and xenon.

19. A heat treatment apparatus comprising:

a reaction tube;

an exhaust means for reducing a pressure in the reaction tube;

a gas supply means for supplying gas into the reaction tube and heating or cooling the gas;

a light source for heating a substrate disposed in the reaction tube; and

means for switching on/off the light source in a pulse form,

wherein the light source is provided outside of the reaction tube, and

wherein while gas heated by the gas supply means is supplied under a condition that the reaction tube is kept in a reduced pressure, the light source is switched on/off in a pulse form to heat the substrate, and thereafter, gas cooled to a temperature equal to or lower than a room temperature by the gas supply means is supplied to cool the substrate.

20. An apparatus according to claim 19, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

21. An apparatus according to claim 19, wherein the gas is at least one selected from the group consisting of nitrogen, helium, argon, krypton, and xenon.

22. A heat treatment apparatus comprising:

a reaction tube;

an exhaust means for reducing a pressure in the reaction tube;

supplying heated gas into a reaction tube;

switching on/off a light source provided outside of the reaction tube in a pulse form
to heat a substrate disposed in the reaction tube; and

supplying gas cooled to a temperature equal to or lower than a room temperature into
the reaction tube to cool the substrate.

28. A method according to claim 27, wherein the light source is at least one selected from
the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a
high-pressure sodium lamp, and a xenon lamp.

29. A method of manufacturing a semiconductor device comprising:

disposing a substrate in a reaction tube;

heating the substrate in a first stage by switching on/off a light source in a pulse form
with a cycle of one second or shorter, the light source provided outside of the reaction tube;
and

heating the substrate in a second stage by switching on/off the light source in a pulse
form with a cycle of one second or longer to heat the substrate disposed in the reaction tube.

30. A method according to claim 29, wherein the light source is at least one selected from
the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a
high-pressure sodium lamp, and a xenon lamp.

31. A method of manufacturing a semiconductor device comprising:

disposing a substrate in a reaction tube;

supplying heated gas to the reaction tube;

heating the substrate in a first stage by switching on/off a light source in a pulse form with a cycle of one second or shorter, the light source provided outside of the reaction tube; and

heating the substrate in a second stage by switching on/off the light source in a pulse form with a cycle of one second or longer to heat the substrate disposed in the reaction tube.

32. A method according to claim 31, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

33. A method of manufacturing a semiconductor device, comprising:

disposing a substrate in a reaction tube;

supplying heated gas into the reaction tube under a reduced pressure; and

heating the substrate disposed in the reaction tube by switching on/off a light source provided outside of the reaction tube in a pulse form.

34. A method according to claim 33, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

35. A method of manufacturing a semiconductor device, comprising the steps of:

disposing a substrate in a reaction tube;

supplying heated gas into the reaction tube under a reduced pressure;

heating a substrate disposed in the reaction tube by switching on/off a light source provided outside of the reaction tube in a pulse form; and

supplying gas cooled to a temperature equal to or lower than a room temperature into the reaction tube to cool the substrate.

36. A method according to claim 35, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

37. A method of manufacturing a semiconductor device comprising:

disposing a substrate in a reaction tube;

keeping the reaction tube under reduced pressure;

heating the substrate in a first stage by switching on/off a light source in a pulse form with a cycle of one second or shorter, the light source provided outside of the reaction tube;

heating the substrate in a second stage by switching on/off the light source in a pulse form with a cycle of one second or longer.

38. A method according to claim 37, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

39. A method of manufacturing a semiconductor device comprising:

disposing a substrate in a reaction tube;

supplying heated gas in the reaction tube while keeping the reaction tube under a reduced pressure;

heating the substrate in a first stage by switching on/off a light source in a pulse form with a cycle of one second or shorter, the light source provided outside of the reaction tube;

heating the substrate in a second stage by switching on/off the light source in a pulse form with a cycle of one second or longer.

40. A method according to claim 39, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

41. A method of manufacturing a semiconductor device, comprising:

disposing a semiconductor film, in which an impurity region of one conductive type is formed, in a reaction tube;

supplying heated gas into the reaction tube; and

heating the semiconductor film disposed in the reaction tube by switching on/off a light source provided outside of the reaction tube.

42. A method according to claim 41, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

43. A method of manufacturing a semiconductor device, comprising:

disposing a semiconductor film, in which an impurity region of one conductivity type is formed, in a reaction tube;

supplying heated gas into the reaction tube;

heating the semiconductor film disposed in the reaction tube by switching on/off a light source provided outside of the reaction tube in a pulse form; and

supplying gas cooled to a temperature equal to or lower than a room temperature into

the reaction tube to cool the semiconductor film.

44. A method according to claim 43, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

45. A method of manufacturing a semiconductor device, comprising:

disposing a semiconductor film, in which an impurity region of one conductivity type is formed, in a reaction tube;

heating the semiconductor film disposed in the reaction tube in a first stage by switching on/off a light source provided outside of the reaction tube in a pulse form with a cycle of one second or shorter; and

heating the semiconductor film in a second stage by switching on/off the light source in a pulse form with a cycle of one second or longer.

46. A method according to claim 45, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

47. A method for manufacturing a semiconductor device, comprising:

disposing a semiconductor film, in which an impurity region of one conductive type is formed, in a reaction tube;

supplying heated gas into the reaction tube;

heating the semiconductor film disposed in the reaction tube in a first stage by switching on/off a light source provided outside of the reaction tube in a pulse form with a

cycle of one second or shorter; and

heating the semiconductor film in a second stage by switching on/off the light source in a pulse form with a cycle of one second or longer.

48. A method according to claim 47, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

49. A method for manufacturing a semiconductor device, comprising:

disposing a semiconductor film, in which an impurity region of one conductive type is formed, in a reaction tube;

supplying heated gas into the reaction tube under a reduced pressure; and

heating the semiconductor film disposed in the reaction tube by switching on/off a light source provided outside of the reaction tube in a pulse form.

50. A method according to claim 49, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

51. A method for manufacturing a semiconductor device, comprising:

disposing a semiconductor film, in which an impurity region of one conductive type is formed, in a reaction tube;

supplying heated gas into the reaction tube under a reduced pressure;

heating the semiconductor film disposed in the reaction tube by switching on/off a light source provided outside of the reaction tube in a pulse form; and

supplying gas cooled to a temperature equal to or lower than a room temperature into the reaction tube to cool the semiconductor film.

52. A method according to claim 51, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

53. A method of manufacturing a semiconductor device, comprising:

disposing a semiconductor film, in which an impurity region of one conductive type is formed, in a reaction tube;

keeping the reaction tube under a reduced pressure;

heating the semiconductor film disposed in the reaction tube in a first stage by switching on/off a light source provided outside of the reaction tube in a pulse form with a cycle of one second or shorter; and

heating the semiconductor film in a second stage by switching on/off the light source in a pulse form with a cycle of one second or longer.

54. A method according to claim 53, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

55. A method of manufacturing a semiconductor device, comprising:

disposing a semiconductor film, in which an impurity region of one conductive type is formed, in a reaction tube;

keeping the reaction tube under a reduced pressure;

supplying heated gas into the reaction tube; and

heating the semiconductor film disposed in the reaction tube in a first stage by switching on/off a light source provided outside of the reaction tube in a pulse form with a cycle of one second or shorter; and

heating the semiconductor film in a second stage by switching on/off the light source in a pulse form with a cycle of one second or longer.

56. A method according to claim 55, wherein the light source is at least one selected from the group consisting of a halogen lamp, a metal halide lamp, a high-pressure mercury lamp, a high-pressure sodium lamp, and a xenon lamp.

57. A method according to claim 25 wherein the semiconductor device is a video camera.

58. A method according to claim 25 wherein the semiconductor device is a digital camera.

59. A method according to claim 25 wherein the semiconductor device is a goggle type display.

60. A method according to claim 25 wherein the semiconductor device is a car navigation system.

61. A method according to claim 25 wherein the semiconductor device is a sound reproduction device.

62. A method according to claim 25 wherein the semiconductor device is a personal computer.

63. A method according to claim 25 wherein the semiconductor device is a game apparatus.

64. A method according to claim 25 wherein the semiconductor device is a portable information terminal.

65. A method according to claim 25 wherein the semiconductor device is an image playback device.

66. A method according to claim 27 wherein the semiconductor device is a video camera.

67. A method according to claim 27 wherein the semiconductor device is a digital camera.

68. A method according to claim 27 wherein the semiconductor device is a goggle type display.

69. A method according to claim 27 wherein the semiconductor device is a car navigation system.

70. A method according to claim 27 wherein the semiconductor device is a sound reproduction device.

71. A method according to claim 27 wherein the semiconductor device is a personal computer.

72. A method according to claim 27 wherein the semiconductor device is a game apparatus.

73. A method according to claim 27 wherein the semiconductor device is a portable information terminal.

74. A method according to claim 27 wherein the semiconductor device is an image playback device.

75. A method according to claim 29 wherein the semiconductor device is a video camera.

76. A method according to claim 29 wherein the semiconductor device is a digital camera.

77. A method according to claim 29 wherein the semiconductor device is a goggle type display.

78. A method according to claim 29 wherein the semiconductor device is a car

navigation system.

79. A method according to claim 29 wherein the semiconductor device is a sound reproduction device.

80. A method according to claim 29 wherein the semiconductor device is a personal computer.

81. A method according to claim 29 wherein the semiconductor device is a game apparatus.

82. A method according to claim 29 wherein the semiconductor device is a portable information terminal.

83. A method according to claim 29 wherein the semiconductor device is an image playback device.

84. A method according to claim 31 wherein the semiconductor device is a video camera.

85. A method according to claim 31 wherein the semiconductor device is a digital camera.

86. A method according to claim 31 wherein the semiconductor device is a goggle type display.

87. A method according to claim 31 wherein the semiconductor device is a car navigation system.

88. A method according to claim 31 wherein the semiconductor device is a sound reproduction device.

89. A method according to claim 31 wherein the semiconductor device is a personal computer.

90. A method according to claim 31 wherein the semiconductor device is a game apparatus.

91. A method according to claim 31 wherein the semiconductor device is a portable information terminal.

92. A method according to claim 31 wherein the semiconductor device is an image playback device.

93. A method according to claim 33 wherein the semiconductor device is a video camera.

94. A method according to claim 33 wherein the semiconductor device is a digital camera.

95. A method according to claim 33 wherein the semiconductor device is a goggle type display.
96. A method according to claim 33 wherein the semiconductor device is a car navigation system.
97. A method according to claim 33 wherein the semiconductor device is a sound reproduction device.
98. A method according to claim 33 wherein the semiconductor device is a personal computer.
99. A method according to claim 33 wherein the semiconductor device is a game apparatus.
100. A method according to claim 33 wherein the semiconductor device is a portable information terminal.
101. A method according to claim 33 wherein the semiconductor device is an image playback device.
102. A method according to claim 35 wherein the semiconductor device is a video camera.
103. A method according to claim 35 wherein the semiconductor device is a digital

camera.

104. A method according to claim 35 wherein the semiconductor device is a goggle type display.

105. A method according to claim 35 wherein the semiconductor device is a car navigation system.

106. A method according to claim 35 wherein the semiconductor device is a sound reproduction device.

107. A method according to claim 35 wherein the semiconductor device is a personal computer.

108. A method according to claim 35 wherein the semiconductor device is a game apparatus.

109. A method according to claim 35 wherein the semiconductor device is a portable information terminal.

110. A method according to claim 35 wherein the semiconductor device is an image playback device.

111. A method according to claim 37 wherein the semiconductor device is a video camera.

112. A method according to claim 37 wherein the semiconductor device is a digital camera.
113. A method according to claim 37 wherein the semiconductor device is a goggle type display.
114. A method according to claim 37 wherein the semiconductor device is a car navigation system.
115. A method according to claim 37 wherein the semiconductor device is a sound reproduction device.
116. A method according to claim 37 wherein the semiconductor device is a personal computer.
117. A method according to claim 37 wherein the semiconductor device is a game apparatus.
118. A method according to claim 37 wherein the semiconductor device is a portable information terminal.
119. A method according to claim 37 wherein the semiconductor device is an image playback device.

playback device.

129. A method according to claim 41 wherein the semiconductor device is a video camera.

130. A method according to claim 41 wherein the semiconductor device is a digital camera.

131. A method according to claim 41 wherein the semiconductor device is a goggle type display.

132. A method according to claim 41 wherein the semiconductor device is a car navigation system.

133. A method according to claim 41 wherein the semiconductor device is a sound reproduction device.

134. A method according to claim 41 wherein the semiconductor device is a personal computer.

135. A method according to claim 41 wherein the semiconductor device is a game apparatus.

136. A method according to claim 41 wherein the semiconductor device is a portable information terminal.

145. A method according to claim 43 wherein the semiconductor device is a portable information terminal.

146. A method according to claim 43 wherein the semiconductor device is an image playback device.

147. A method according to claim 45 wherein the semiconductor device is a video camera.

148. A method according to claim 45 wherein the semiconductor device is a digital camera.

149. A method according to claim 45 wherein the semiconductor device is a goggle type display.

150. A method according to claim 45 wherein the semiconductor device is a car navigation system.

151. A method according to claim 45 wherein the semiconductor device is a sound reproduction device.

152. A method according to claim 45 wherein the semiconductor device is a personal computer.

153. A method according to claim 45 wherein the semiconductor device is a game

apparatus.

154. A method according to claim 45 wherein the semiconductor device is a portable information terminal.

155. A method according to claim 45 wherein the semiconductor device is an image playback device.

156. A method according to claim 47 wherein the semiconductor device is a video camera.

157. A method according to claim 47 wherein the semiconductor device is a digital camera.

158. A method according to claim 47 wherein the semiconductor device is a goggle type display.

159. A method according to claim 47 wherein the semiconductor device is a car navigation system.

160. A method according to claim 47 wherein the semiconductor device is a sound reproduction device.

161. A method according to claim 47 wherein the semiconductor device is a personal computer.

162. A method according to claim 47 wherein the semiconductor device is a game apparatus.
163. A method according to claim 47 wherein the semiconductor device is a portable information terminal.
164. A method according to claim 47 wherein the semiconductor device is an image playback device.
165. A method according to claim 49 wherein the semiconductor device is a video camera.
166. A method according to claim 49 wherein the semiconductor device is a digital camera.
167. A method according to claim 49 wherein the semiconductor device is a goggle type display.
168. A method according to claim 49 wherein the semiconductor device is a car navigation system.
169. A method according to claim 49 wherein the semiconductor device is a sound reproduction device.

170. A method according to claim 49 wherein the semiconductor device is a personal computer.

171. A method according to claim 49 wherein the semiconductor device is a game apparatus.

172. A method according to claim 49 wherein the semiconductor device is a portable information terminal.

173. A method according to claim 49 wherein the semiconductor device is an image playback device.

174. A method according to claim 51 wherein the semiconductor device is a video camera.

175. A method according to claim 51 wherein the semiconductor device is a digital camera.

176. A method according to claim 51 wherein the semiconductor device is a goggle type display.

177. A method according to claim 51 wherein the semiconductor device is a car navigation system.

178. A method according to claim 51 wherein the semiconductor device is a sound

reproduction device.

179. A method according to claim 51 wherein the semiconductor device is a personal computer.

180. A method according to claim 51 wherein the semiconductor device is a game apparatus.

181. A method according to claim 51 wherein the semiconductor device is a portable information terminal.

182. A method according to claim 51 wherein the semiconductor device is an image playback device.

183. A method according to claim 53 wherein the semiconductor device is a video camera.

184. A method according to claim 53 wherein the semiconductor device is a digital camera.

185. A method according to claim 53 wherein the semiconductor device is a goggle type display.

186. A method according to claim 53 wherein the semiconductor device is a car navigation system.

187. A method according to claim 53 wherein the semiconductor device is a sound reproduction device.

188. A method according to claim 53 wherein the semiconductor device is a personal computer.

189. A method according to claim 53 wherein the semiconductor device is a game apparatus.

190. A method according to claim 53 wherein the semiconductor device is a portable information terminal.

191. A method according to claim 53 wherein the semiconductor device is an image playback device.

192. A method according to claim 55 wherein the semiconductor device is a video camera.

193. A method according to claim 55 wherein the semiconductor device is a digital camera.

194. A method according to claim 55 wherein the semiconductor device is a goggle type display.

195. A method according to claim 55 wherein the semiconductor device is a car navigation system.

196. A method according to claim 55 wherein the semiconductor device is a sound reproduction device.

197. A method according to claim 55 wherein the semiconductor device is a personal computer.

198. A method according to claim 55 wherein the semiconductor device is a game apparatus.

199. A method according to claim 55 wherein the semiconductor device is a portable information terminal.

200. A method according to claim 55 wherein the semiconductor device is an image playback device.